DOCUMENT RESUME

ED 329 919 CS 010 470

AUTHOR Stahl, Steven A.; And Others
TITLE Defining the Role of Prior Knowledge and Vocabulary in Reading Comprehension: The Retiring of Number 41. Technical Report No. 526.
INSTITUTION Bolt, Beranek and Newman, Inc., Cambridge, Mass.; Illinois Univ., Urbana. Center for the Study of Reading.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE Apr 91
CONTRACT G0087-C1001-90
NOTE 25p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Baseball; Context Clues; Grade 10; High Schools; *Prior Learning; Protocol Analysis; *Reader Text Relationship; *Reading Comprehension; Reading Research; Reading Skills; Reading Strategies; *Recall (Psychology); Schemata (Cognition); Vocabulary
IDENTIFIERS Illinois; New York (Long Island); Text Factors

ABSTRACT

Using a newspaper article about a ceremony marking the retirement of baseball player Tom Seaver's uniform number, a study examined: (1) the effects of knowledge of baseball in general and of the career of Tom Seaver in particular; and (2) the effects of knowledge of word meanings in general and of words used in the passage specifically on 10th graders' recall of different aspects of passage content. Subjects, 159 10th graders from Illinois and Long Island, read a target passage and then were assessed on baseball knowledge and vocabulary knowledge. Vocabulary knowledge tended to affect the number of units recalled overall, whereas prior knowledge influenced which units were recalled. Prior topic knowledge influenced whether subjects produced a "gist" statement in their recall and how well they recalled numbers relevant to Seaver's career. High-knowledge subjects also tended to focus more on information given about Seaver's career than did low-knowledge subjects. Specific and general domain knowledge were so closely related that their effects could not be disentangled. A qualitative analysis of the protocols confirmed the general trends in the quantitative analysis. Results suggest both that domain knowledge and vocabulary have independent effects on comprehension and that these effects are on what is comprehended as well as on how much is comprehended. (Three tables of data are included; 20 references and 2 appendixes containing the reading selection and baseball terminology are attached.) (Author/KEH)

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ED329919

CENTER FOR THE STUDY OF READING

Technical Report No. 526

DEFINING THE ROLE OF PRIOR KNOWLEDGE AND VOCABULARY IN READING COMPREHENSION: THE RETIRING OF NUMBER 41

Steven A. Stahl
University of Georgia

Victoria Chou Hare
University of Illinois at Chicago

Richard Sinatra
James F. Gregory
St. John's University, Jamaica, NY

April 1991

University of Illinois at Urbana-Champaign
51 Gerty Drive
Champaign, Illinois 61820

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CS010470

The work upon which this publication was based was supported in part by the Office of Educational Research and Improvement under Cooperative Agreement No. G0087-C1001-90 with the Reading Research and Education Center. The publication does not necessarily reflect the views of the agency supporting the research.

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Abstract

Although both prior topic knowledge and vocabulary knowledge have been known to affect comprehension in general, less is known about the specifics of the interactions between these factors. Using a newspaper article about a ceremony marking the retirement of baseball player Tom Seaver's uniform number, a study examined (a) the effects of knowledge of baseball in general and of the career of Tom Seaver in specific and (b) the effects of knowledge of word meanings in general and of words used in the passage specifically on 10th graders' recall of different aspects of passage content. Vocabulary knowledge tended to affect the number of units recalled overall, whereas prior knowledge influenced which units were recalled. Prior topic knowledge influenced whether subjects produced a gist statement in their recall and how well they recalled numbers relevant to Seaver's career. High-knowledge subjects also tended to focus more on information given about his career than did low-knowledge subjects. Specific and general domain knowledge were so closely related that their effects could not be disentangled. A qualitative analysis of the protocols confirmed the general trends in the quantitative analysis. Results suggest both that domain knowledge and vocabulary have independent effects on comprehension and that these effects are on what is comprehended as well as on how much is comprehended.

DEFINING THE ROLE OF PRIOR KNOWLEDGE AND VOCABULARY IN READING COMPREHENSION: THE RETIRING OF NUMBER 41

The effects of both prior topic knowledge and vocabulary knowledge on reading comprehension are well established, at least in general terms. We know, for example, that people with high amounts of prior topic knowledge comprehend text better than do those with lesser amounts (for review see Anderson & Pearson, 1984). We also know that people who know more word meanings comprehend text better than do those who know fewer words (for review see Graves, 1986).

Yet the specifics of the relationships between these factors have not been fully explored. One reason is that the concepts of prior knowledge, vocabulary knowledge, and comprehension have been treated globally. For example, prior knowledge has been treated as a dichotomy, by comparing high- and low-knowledge subjects, or by comparing subjects either pretaught or not taught important concepts. But we know that people vary along a continuum in their knowledge of real domains, from no knowledge to little knowledge to some knowledge to much, detailed knowledge.

Similarly, vocabulary knowledge has been manipulated by substituting difficult synonyms for varying proportions of text words and by giving subjects an easy or a difficult version. However, word knowledge can also be put along a continuum between no knowledge and complete familiarity (see Curtis, 1987).

In addition, comprehension has not always been clearly defined in many of these studies. Rote recall of facts and providing a gist summary are very different tasks, requiring different mental processes and knowledge. Yet these tasks and others have been used to measure comprehension in studies examining the relations between prior topic knowledge, vocabulary knowledge, and comprehension.

This report is part of a line of studies attempting to disentangle these three factors by looking at specific effects of different levels of vocabulary knowledge and prior knowledge on different comprehension tasks. Our goal is to examine the specific effects of these factors, both individually and interactively, on comprehension, to better understand both the nature of comprehension and how to teach it.

Prior Knowledge and Comprehension

Anderson and Pearson (1984) suggest three ways in which prior knowledge may affect comprehension. Prior knowledge may (a) enable students to make inferences about their reading, (b) direct their attention to information important in a knowledge domain, and/or (c) provide a plan for recall. These are not mutually exclusive. Indeed, prior knowledge affects comprehension in all of these ways. We will discuss these ways briefly in turn.

Inferences. Because authors never specify all the information needed to understand a text, some domain knowledge is necessary to understand relations between ideas in a text. For example, encountering a sentence like "Jose Canseco hit the ball out of the park," a reader with minimal baseball knowledge can infer that the instrument used to hit the ball was a bat, even though this is not stated. When the reader next encounters a sentence like "The bat broke," his or her knowledge allows the automatic inference that the bat belonged to and was used by Canseco. A person without such knowledge could wonder, for example, whether the bat was picked up by Canseco and broken specifically to celebrate his achievement, or even whether the "bat" was a flying mammal. Such misperceptions seem absurd to those of us with even a minimal amount of baseball knowledge, but might be plausible interpretations by a reader armed with no more than a dictionary meaning of each word (see Miller & Gildea, 1987). Because such inferences serve as the "glue" to hold together individual propositions in a passage, one might assume that variations in prior topic knowledge would affect the coherence of one's recall.

Pearson, Hansen, and Gordon (1979) found that second-grade students' knowledge of spiders affected their ability to answer questions about a passage on that topic involving the coordination of information across sentences. In their study, such knowledge had no effect on answering questions involving only a single sentence. Similarly, Chiesi, Spillich, and Voss (1979) had adults rated as high or low in baseball knowledge recall a play-by-play account of a baseball game. They found that recalls of subjects rated as high in baseball knowledge were more coherent and preserved information important to the goals of the game in their recall, while the recalls of subjects rated as low in baseball knowledge were more fragmented.

Attention. The Chiesi et al. (1979) results could also be explained partially by a selective attention hypothesis, which suggests that people who have more relevant domain knowledge know what information is important and what is trivial. In the Chiesi et al. study, high-knowledge subjects tended to recall information such as base hits, steals, and strikeouts more than did low-knowledge subjects, while low-knowledge subjects tended to recall more incidental information, such as the size of the crowd, than did high-knowledge subjects.

The selective-attention hypothesis has been tested more directly by Goetz, Schallert, Reynolds, and Radin (1983), who had subjects read a passage originally used in a study by Pichert and Anderson (1977). This passage concerned two boys playing hooky. Subjects in both studies read the passage either from the perspective of a person interested in buying the home described or from the perspective of a burglar interested in breaking into the home. Pichert and Anderson found that subjects recalled more information relevant to the assigned perspective. Goetz et al. confirmed this finding, and also found that readers spent more time reading sentences relevant to the perspective taken. This differential allocation of time may lead to superior recall of information relevant to the assigned perspective.

Recall. Another hypothesis to explain these results is that prior knowledge aids in the recall of information, not at the point of encoding. The strongest evidence for this hypothesis comes from a study by Anderson and Pichert (1978), using the same homebuyers/burglars passage. They found that when subjects shifted perspective, homebuyers shifting to burglars and vice versa, they were able to recall information they did not previously recall. There is some evidence from the subjects' debriefing that they used their knowledge of the interests of homebuyers and burglars to interrogate their recall of the text, asking such questions as "Did they discuss the silverware?" or "Did they talk about the condition of the roof?" These effects may have been pronounced since the shift of perspective recall task took place 24 hours after reading the passage. Prior knowledge might not have as great an effect on more immediate recall when the exact wording may be fresher in readers' memory.

These three hypotheses probably all describe aspects of the prior knowledge-comprehension relationship. One would expect subjects high in prior knowledge to recall information in a more coherent manner, to make more knowledge-based inferences, and to have a better idea of which ideas in the text are important and which are not.

Vocabulary and Comprehension

The effects of vocabulary knowledge on comprehension are among the best established in reading research. Research from readability and test construction, as well as from the effects of vocabulary instruction on reading comprehension, has established that children with more vocabulary knowledge comprehend text better than those with less (for review see Graves, 1986).

Given the strong support for these general effects, it is surprising that there are fewer studies examining specific effects of vocabulary knowledge on comprehension. One such study, Omanson, Beck, McKeown, and Perfetti (1984), tested two theoretical models of the effects of unknown words on recall. In one model, a reader was hypothesized to substitute a known word for an unknown word based on information available from the context. In the second, the reader was hypothesized to suppress

information from the proposition that contained the unknown word. The first model predicted that the proposition or a synonymous proposition would appear in subjects' recall. The second model predicted that the proposition would be less likely to appear in students' recall protocols. Omanson et al. found that the second model best accounted for the patterns found in recall. But more important than which particular model proved to be better was the finding that the effects of vocabulary difficulty appeared to be on the individual proposition level rather than at a more global level. Indeed, in the Chiesi et al. (1979) study, subjects with low baseball knowledge, but presumably enough vocabulary knowledge to understand the baseball play-by-play, recalled nearly as many propositions as the high-baseball-knowledge subjects, but the propositions recalled by the high- knowledge subjects tended to be more important to the topic than those recalled by the low-knowledge subjects.

Prior Knowledge and Vocabulary

Because readers bring both topic knowledge and vocabulary to bear in comprehending text, it has been hypothesized that readers high in domain knowledge but low in vocabulary knowledge may use their domain knowledge to compensate for their lack of word knowledge, or vice versa. A number of studies (Freebody & Anderson, 1983, ex. 2; Stahl & Jacobson, 1986; Stahl, Jacobson, Davis, & Davis, 1989) have examined this question, and all have failed to find such an interaction between prior knowledge and vocabulary knowledge.

Instead, domain knowledge and vocabulary knowledge appear to have independent and separate effects on comprehension. Vocabulary difficulty seems to affect tasks that are sensitive to the formation of a microstructure (Kintsch & van Dijk, 1978). A microstructure contains a representation of individual propositions, connected by cohesive links. Such tasks include recognition of sentences that appeared in the text (Stahl & Jacobson, 1986), performance on cloze tasks, written free recall of central and supporting information, and recalling the order of events (Stahl et al., 1989). Domain knowledge seems to affect tasks involving the development of a macrostructure. A macrostructure contains a representation of the gist or most important information in the passage. Such tasks include summarizing passages (Freebody & Anderson, 1983) and rating the importance of information in texts (Stahl et al., 1989), as well as performance on written free-recall tasks (Freebody & Anderson, 1983; Stahl et al., 1989).

In these studies, passages were manipulated so that they were either familiar or unfamiliar, through use of a familiar or an unfamiliar culture in Freebody and Anderson's (1983) study or through preteaching about an unfamiliar culture in our earlier studies (Stahl & Jacobson, 1986; Stahl et al., 1989). However, we feel that knowledge is best characterized along a continuum. Similarly, the passages in these studies were created to have either hard or easy vocabulary. Again, readers vary continuously in terms of their knowledge of the vocabulary in a passage. These artificial experimental limits may have influenced the results of the studies.

In addition, these studies treated both domain knowledge and vocabulary very generally. Reviewing instructional recommendations based on schema theory, there seem to be conflicts as to whether one is aided by specific knowledge about the topic of the passage (topic knowledge) or whether general knowledge of the domain (domain knowledge) will suffice. We are not sure whether specific topic knowledge is necessary for comprehension, or whether adequate domain knowledge, or even analogous knowledge, can take its place. This remains an open question.

Another open question is whether a measure of general vocabulary knowledge is as good a predictor of comprehension as a measure of the specific vocabulary used in the passage. General vocabulary knowledge is highly related to general aptitude and the relation between such a measure and comprehension would be supportive of a position that it is such aptitude, not necessarily knowledge of the specific words used in a passage, that relates to comprehension (see Anderson & Freebody, 1981, for a description of this position).

Our study was intended to replicate and extend the studies reviewed above (Freebody & Anderson, 1983; Stahl & Jacobson, 1986; Stahl et al., 1989), examining the differential effects of prior knowledge and vocabulary difficulty on text comprehension, using a different passage, a different knowledge domain (baseball), and a different methodology to assess continuous variations in both prior knowledge and vocabulary. We chose baseball as a target domain because it is a well-structured knowledge domain (Chiesi et al., 1979). There are considerable variations in baseball knowledge, and such variations are socially acceptable. Unlike academic knowledge, there is no social stigma attached to a lack of baseball knowledge. Thus, self-reports are more likely to be accurate, since a person admitting lack of baseball knowledge would not be branded as deficient. A second aspect of the design of the study was to look at differences in how both specific and general measures of both knowledge and vocabulary predict comprehension, as a partial step in specifying exactly what is meant by domain knowledge and vocabulary knowledge.

Method

Subjects

Subjects were 159 10th graders, 85 from a rural west central Illinois community located about 100 miles from St. Louis (in the rooting area of the Cardinals) and 74 from a suburban Long Island community located about 60 miles from Queens, New York (in the rooting area of the Mets). The mean sample score was at the 64th percentile on the vocabulary subtest of the Nelson-Denny Reading Tests, using national norms, with both subsamples having nearly identical mean scores. The Illinois subjects came from a small town whose major industry is agriculture. All of these subjects were white, with working-class or middle-class parents. The Long Island subjects were also predominantly white, but 10% were African-American. Their parents were also predominantly middle class. In both samples, males and females were equally represented. The participating school for the Long Island group provided scores from the Test of Cognitive Skills, a group-administered ability measure. The mean Cognitive Skills index for this sample was 112.10 (sd = 15.85), suggesting that this sample has somewhat above average ability.

These particular localities were chosen to find a wide variety of knowledge about Tom Seaver, a pitcher who spent most of his career with the New York Mets. It was assumed that more of the Long Island subjects would be knowledgeable about Seaver than the subjects in Illinois. This natural variation in subjects' knowledge would allow examination of the effects of general and specific knowledge on comprehension of a passage written about Seaver.

Materials

Target passage. The target passage was a 1,100-word article written about the retiring of Seaver's uniform number (41) at Shea Stadium, which was taken from *The Sporting News*. (The passage is given in the Appendix.) *The Sporting News* is a weekly newspaper intended for sports enthusiasts and assumes that its readership is relatively knowledgeable and interested in sports, especially baseball. According to the Flesch readability formula, the passage was written at about a 10th-grade reading level.

We felt that the use of a naturally occurring passage would be preferable to the use of contrived passages. Researcher-contrived passages may differ from naturally occurring passages on a number of unintended dimensions. Researchers' views of good, clear writing appear to differ from those of writers in popular magazines and newspapers (Graves et al., 1987). The use of naturally occurring passages may provide insights into the dynamics of the reading process that contrived passages do not.

There were important differences between this passage and passages usually used in text comprehension research. First, there was not one, but three macrostructures, each dealing with a different theme. The introduction and conclusion clearly signalled that the topic of primary importance was the Tom Seaver

Day ceremony, but it was not clearly signalled whether the progression of numbers on Seaver's uniform through his career or the information about his career was of secondary importance. From a baseball perspective, it was Seaver's career that led to the retiring of his number. Without that perspective, it could be perceived that the passage is about the progression of numbers he wore in his career. Second, there was more irrelevant information, what sports writers might call "color," than is usual in a typical text comprehension study, in which textbook writing is used. Color, or interesting nuggets of information, is an important component of sportswriting, but not of textbook writing (see Graves et al., 1987).

Because of the unusual structure and the use of color, as well as the use of baseball terms, especially player numbers, we judged this passage to be difficult to read without baseball knowledge.

Vocabulary measures. Two measures were used to assess the students' vocabulary knowledge. One was the Nelson-Denny vocabulary subtest, administered according to standard directions. The other was a checklist, adapted from Anderson & Freebody (1983), in which 15 words from the passage we judged might be difficult for 10th graders were embedded into a 100-item checklist. (These words are listed in the Appendix.) This checklist included different types of nonsense words, frequent words of similar length as the target words, baseball terms, and false prefix words. The number of target words checked as known, corrected for response bias as recommended by Anderson and Freebody, was the measure of subjects' knowledge of specific words in the passage. This measure has been found to be a reliable measure of vocabulary knowledge, with adequate concurrent validity. Anderson and Freebody, for example, found that their checklist correlated from .85 to .92 with an interview measure of children's knowledge of the same words. In general, they found that the checklist measures simple familiarity with the words and that the relations between the checklist and other measures of word knowledge decreased as more in-depth knowledge was required (see also Curtis, 1987). In our study, it had a moderate correlation of .51 with the Nelson-Denny. Considering that the words on the checklist were different from those on the Nelson-Denny and not selected to represent a range of difficulty, as the Nelson-Denny's were, this correlation is relatively high.

Baseball knowledge measures. Three measures were used to assess subjects' baseball knowledge. First was a free-association task that involved giving students a target word and having them write as many associates to that word as possible within a minute. Scoring was done according to the criteria of Zakaluk, Samuels, and Taylor (1986), who found such a task to be a reliable measure of prior knowledge. One practice stimulus was used to acquaint subjects with the task, followed by two target stimuli--*Baseball* and *Tom Seaver*. The responses to the Baseball stimulus were intended to be a measure of general domain knowledge, while those to Tom Seaver were used as a measure of specific topic knowledge. A sample of protocols was used to establish interrater reliability, which was above .90 for both stimuli.

Second, 17 terms used exclusively in baseball were added to the vocabulary checklist described above. Examples of these terms are *bunt, balk,* and *shortstop*. (These 17 terms are also listed in the Appendix.) These were analyzed as described above and used as another measure of general baseball knowledge.

In addition, a short questionnaire was used to assess subjects' perceived interest in baseball, the number of baseball games they had seen on television in the last year, and the number of games they attended in person. Subjects were also asked how many Mets games they have seen on television and in person. The baseball-general items were combined as a measure of baseball interest; the Mets-specific items were combined as a measure of specific interest in the Mets. The items were combined by first converting them to a *z*-scale and then adding the *z*-scores to create the variable analyzed.

Comprehension measures. Comprehension was assessed using a written free recall. Three measures were derived from the recall. First was the total number of idea units recalled. The entire passage was first divided into idea units. Each idea unit in the recall was rated as to whether it matched one in the

text. Two raters working independently scored a sample of the protocols with above 90% interrater reliability.

One might expect that the different themes would have different salience to subjects with higher or lower amounts of knowledge. Therefore, these idea units were divided further into whether they related to the topics of Tom Seaver Day, Seaver's career with the Mets, or the numbers Seaver wore through the years. Recall of information related to each topic was examined separately in a post hoc analysis.

Second, recalls were rated as to the presence of gist units, or statements of one of the three themes. Because there were multiple themes, there were several possible gist units. We felt that subjects who stated one or more of the themes were comprehending the text differently than were those who only recounted facts, as might be expected from the hypothesis suggesting that prior knowledge affects readers' ability to make connecting inferences. This measure was meant to capture that difference. A graduate student reviewed a sample of the protocols with 96% total agreement.

A third measure was the amount of numbers used in the recall. Because statistics are important in baseball, especially in this passage, subjects with greater prior baseball knowledge should be more sensitive to numbers in the text and include more in their recall, as might be expected from the selective attention hypothesis discussed earlier. Because all numbers were not equally important, we chose eight numbers that appeared clearly relevant to the topic of baseball (such as Seaver's career wins, strikeouts, and earned-run average [ERA]) and eight that appeared less relevant to the topic of baseball (such as the attendance and the date of the ceremony). The remaining numbers used in the text were, we thought, ambiguous in their relevance and were not used in this post hoc analysis.

Procedure

Subjects were seen on two consecutive days in their classes by one of the authors. Because the Long Island school only allowed us two 45-minutes class periods to complete our data collection, procedures were chosen for efficient administration. On the first day, subjects were given the Nelson-Denny vocabulary test according to test directions, the vocabulary checklist with the instruction to check words that they thought were real words, and the free-association task. On the second day, subjects were asked to read the passage. Upon completion, they answered a study skills questionnaire, designed to be a filler task, and then were asked to "write down what they remember from the Seaver passage." Following the free recall, subjects completed the multiple-choice task, and then the questions about their interest in and knowledge about baseball and the Mets.

Results

Quantitative Analysis

Description of samples. The means and standard deviations for both samples are shown on Table 1. The Illinois and Long Island samples differed significantly only on their knowledge of Seaver as expected and on the number of free associates to *baseball*. Because of the differences in rooting areas, we expected subjects in Long Island to know more about Seaver. However, there seemed to be quite a few Illinois subjects who knew as much about Seaver as the New Yorkers. Forty-eight percent of our subjects (76) did not have any knowledge of Seaver. Of the remaining 83 subjects, 50 were in the Long Island sample and 33 were in Illinois.

[Insert Table 1 about here.]

Validation of measures. Given the use of multiple measures in this study, it was important to test their validity, or whether in fact they seemed to measure what they were intended to.

To examine the construct validity of our measures, we performed a confirmatory principal components analysis. The correlation matrix used as a basis of the analysis is presented on Table 2 and the results of this principal components analysis, with varimax rotation for a two-factor solution is shown in Table 3. This analysis confirmed our expectations that there were two factors underlying the predictor variables. Using a loading of greater than .40 as criteria, the Nelson-Denny vocabulary test score, and the number of target words checked on the checklist load on one factor. The number of free associates in response to *Tom Seaver* and the adjusted number of baseball words checked on the checklist load on the other factor. This solution accounts for 59% of the total variance.

[Insert Tables 2 and 3 about here.]

Except for the Free Association - *Baseball* variable, the other variables seem to line up on either a baseball knowledge factor or a vocabulary factor. The Free Association - *Baseball* variable relates most strongly to the vocabulary factor, and approaches, but does not reach, our .40 criteria. This may reflect the generality of the probe. Because we gave credit for any reasonable response, scores on this measure may reflect general knowledge of the world, rather than specific baseball knowledge. It also may reflect verbal fluency.

The two-factor solution on Table 3 was derived using a criteria of including only factors with an eigenvalue greater than one. A third potential factor on the initial analysis had an eigenvalue of .988. In a three-factor solution, the first two factors are similar to those on Table 3, but the Free Association - *Baseball* loads exclusively on the third factor and its loading on Factor 1 drops from .395 to .203. This further suggests that the Free Association - *Baseball* task is measuring something other than the two other measures of domain knowledge.

Although the Free Association - *Seaver* task was intended to capture specific knowledge about Seaver, we feel that responses actually measure the depth of subjects' baseball knowledge. We, therefore, decided to use the Free Association - *Seaver* responses as one of our prior knowledge variables and the Baseball Word Knowledge measures. Because of the ambiguity of what the Free Association - *Baseball* was measuring, it was dropped from further analysis. The Target Word Knowledge and Nelson-Denny were used as the two vocabulary variables.

Prior Knowledge, Vocabulary, and Comprehension

To examine the effects of these factors on comprehension, we used a hierarchical regression procedure. Variables representing one factor were first included in a regression equation as a block, followed by the other block. Then the procedure was reversed. Hypotheses were tested by examining the relative amounts of unique variance accounted for by one factor after the other was included (or change in R^2).

Idea units. From earlier research, it was hypothesized that the vocabulary factor would more strongly predict the number of units recalled from the text, because this is a measure of the content of the microstructure. The vocabulary variables accounted for 15.1% of the variance when entered first ($p < .001$), with the domain knowledge variables accounting for only a non-significant additional 2.7%. When the domain knowledge variables were entered first, they accounted for a non-significant 4.4% of the total variance, while the vocabulary variables contributed an additional 13.4% of the variance.

When the themes were examined individually, an interesting pattern emerged. As in the overall analysis, the vocabulary measures accounted for the largest amount of variance in the recall of units dealing with

Tom Seaver Day and Seaver's numbers through the years. However, for the topic of Seaver's career, it was the baseball knowledge measures that contributed the largest amount of variance. When these measures were entered first, they accounted for 10.2% of the total variance ($p < .005$), with the vocabulary factors adding only an additional 0.2% of the variance. When the vocabulary measures were entered first, they accounted for less than 1% of the total variance and the knowledge measures over 9%.

Gist units. It was also hypothesized that the domain knowledge variables would best predict the presence of gist units in recall as well as the amount of numbers included. The results were in accordance with this hypothesis, but total model for gist units accounted for a disappointing 6.9% of the variance. When entered first, the domain knowledge variables accounted for 5.8% of the variance ($p < .02$); the vocabulary factor contributed less than an additional 1.1%. When reversed, the vocabulary factor contributed only 1.8%, with the domain knowledge variables contributing an additional 5.1%.

Because there were three different themes in the passage, there were three possible gist statements. We did not feel that a person who gave three or two gist statements necessarily comprehended better than a person who gave only one statement. A reader could be satisfied that the one statement given is the gist and the other themes are less relevant. Therefore, we reanalyzed the gist score as a dichotomous variable, assigning a score of 0 for no gist statements and 1 for one or more.

Because the gist score used as a dependent variable was dichotomous, we used discriminant analysis to parallel the regression analyses used with the other variables. In this analysis, the three knowledge variables defined by the factor analysis (Baseball Interest, $F(1,144) = 4.352$, $p<.05$; Free Association - Seaver, $F(1,144) = 5.929$, $p<.02$; Baseball Vocabulary, $F(1,144) = 4.879$, $p<.03$) each contributed significantly to the discrimination between subjects who did or did not provide gist statements, while the two vocabulary items, the Nelson-Denny score and the Target Word vocabulary score, did not.

Numbers. For the amount of numbers included in the recall, both factors were significant predictors. When the vocabulary factors were included first, they accounted for 8.9% of the variance ($p < .01$), with the domain knowledge variables contributing an additional 10.9% of the variance ($p <.01$). When the domain knowledge factors were entered first, they accounted for 11.5% of the variance ($p < .001$), with the vocabulary factors adding an additional 8.3%.

From the selective attention hypothesis described above, we expected that persons with more domain knowledge would recall more relevant numbers, since certain types of numbers (ERA, strikeouts, and so on) are important to the domain, while other types of numbers (crowd size, date of the ceremony, and so on) are not. For the relevant numbers, the knowledge measures accounted for 16.0% of the total variance when entered first, with the vocabulary measures adding only an additional 0.3%. For the irrelevant numbers, the vocabulary measures accounted for 8.2% of the total variance. The knowledge measures added only an additional 3.7%, roughly the same amount of variance accounted for when they were entered first.

Mets knowledge. All of the regression equations reported above were recalculated adding the Mets items from the questionnaire after the variance accounted for by the other factors was removed. In no case did specific interest in or knowledge of the New York Mets add a significant amount of prediction.

Qualities of Recall

There seemed to be at least three relatively unusual approaches to recalling the information from this passage. These approaches seem to be adaptations to the structure of information in the passage. They are presented here as extreme examples of patterns to illustrate trends in the quality of the recalls. For logistical reasons, this analysis was performed only with the 85 protocols from the Illinois sample.

Listers. One approach to recall was to list information in the text as unrelated facts. Listers often did not use paragraphs, but, even when they did, there was a fragmented quality to their recall. For example, one subject wrote:

> He played for the New York Mets.
>
> He had 311 victories.
>
> He had 3,460 strikeouts.
>
> He had a 2.86 ERA.
>
> He had 113 victories for the Mets.
>
> He had a 19 strikeout performance in the 1969 World Series, the last ten were in a row.
>
> He had a perfect game against the Chicago Cubs in the World Series.
>
> He was a terrific ballplayer.
>
> He had different numbers through little league to the Mets. Some were for example 37, 21, 41 and some more.
>
> He played for the White Sox.
>
> He played for the Reds.

Although this subject had moderately high baseball knowledge, listers were distributed through the range of baseball knowledge. Seventeen of the 26 listers in the Illinois sample were below the group average on the Nelson-Denny, suggesting a tendency for low-vocabulary knowledge subjects to produce a recall consisting of unconnected statements.

Gisters. There were only two clear gisters in the Illinois sample. They may, however, represent an extreme of a pattern found throughout the recall protocols. The two gisters presented only a few main idea statements in their recall, with no supporting information, such as:

> The passage told us about a baseball player named Tom Seaver and told us how about he got the number 41 and what kind of person the man was. It told us about games and teams he played in.

Both of these gisters showed high knowledge about Tom Seaver in the Free-Association Task (6 and 4 items) and had low vocabulary scores relative to the sample. It appeared that these subjects were using their knowledge to get a general idea of the passage, but either had difficulties recalling the particulars or did not choose to put those in their recalls.

Reconstructors. Another pattern found was the tendency to reconstruct the information in the passage so that it created a coherent narrative, without the flashbacks and flash-forwards. Thirty seven of the Illinois sample engaged in some reordering of units in their recall, some as complex as this:

> Tom Seaver was one of the great pitchers in professional baseball. He won 311 games, had one shutout, and over 300 strikeouts. His earned run average, ERA, was under 3.00. These are outstanding statistics for any pitcher.

> Tom Seaver wore number 41 on his jersey. This number had no particular value to Seaver until it was retired at Shea Stadium in New York. His number now hangs beside Gil Hodges' and Casey Stengel's numbers. Casey Stengel's number was 14, but Tom's was reversed this meant alot to Tom.
>
> Seaver told reporters if his number was ever to be retired he would not stand behind the plate. They day finally came, and he kept his word. Tom Seaver walked away from his family and friends, and he went to the pitchers mound to say goodby to over 40,000 fans at Shea and millions others elsewhere.

Although this subject is a high-knowledge subject, reorganizers could be found at all levels of knowledge. As found in the quantitative analysis, low-knowledge subjects tended to focus on Seaver's uniform numbers, while high-knowledge subjects tended to focus on Seaver's career, as in this example. Reconstructors, however, tended to be above average on the Nelson-Denny.

Approaches to recall. Although there were many subjects whose protocols did not fit neatly into one of the three categories, these three approaches seem to be prototypical. The reconstruction approach seems to produce the most coherent protocols, but to reconstruct a text such as this is mentally difficult and appears to require relatively high verbal ability. For subjects with less ability, and subjects with above average verbal ability but not the motivation to reorder, there seem to be two strategies. Subjects with high knowledge used that knowledge to get a few gist statements out of the text, ignoring or failing to recall details. Other subjects produced lists of disconnected facts, without attempting to connect them into a coherent macrostructure.

Discussion

Using a very different passage, with different types of measures of both prior knowledge and vocabulary, the basic results of this study confirm those of Stahl et al. (1989). Although the results presented here are necessarily limited to one passage and one knowledge domain, the results fit into an emerging picture. Vocabulary difficulty appears to have had its major effects on microstructure tasks, in this case the recall of individual propositions, as well as the amount of numbers included. Both vocabulary measures, general and specific, had similar effects.

Baseball knowledge appears to influence subjects' macroprocessing. Subjects with low prior knowledge appear able to recall as many facts as those with high prior knowledge, but the high-prior-knowledge subjects are better able to infer an organization to those facts. Baseball knowledge also appears to affect subjects' recall of numbers. In most domains, specific numerical information is unimportant and can be forgotten. In baseball, statistics are important, as subjects interested in baseball seem to know. High-knowledge subjects recalled more statistics relevant to Seaver's career in baseball than did low-knowledge subjects. Recall of less relevant numbers (such as the attendance and date of Tom Seaver Day) was affected only by vocabulary knowledge.

One can also see that domain knowledge affected subjects' ability to selectively attend to different portions of the text, as suggested by Goetz et al. (1983). Higher knowledge subjects seemed to focus on information more important to the domain (such as relevant numbers) and seemed better able than lower knowledge subjects in perceiving the relative importance of the three themes in the article. This does not say that they were not using that knowledge to make inferences or to aid specifically in recall, as suggested by Anderson and Pearson (1984). These other background-knowledge effects on comprehension were not tested directly in this study.

Micro- and Macro-Comprehension?

If vocabulary difficulty and domain knowledge affect comprehension in different ways, comprehension itself might be divided into two separable processes--a knowledge-driven gist type of comprehension and a more detail-oriented type. The apparent separability of these processes has implications for the study of models of comprehension. In Kintsch and van Dijk's (1978) model, schema-based and text-based macro-operations both work together to create a coherent macrostructure. This account is consistent with the results presented here.

As in earlier studies, however, vocabulary and domain knowledge did not interact, or subjects who were low in one knowledge area did not use their strengths in the other to compensate. This compensatory mechanism is implied in models such as those of Stanovich (1980). His interactive-compensatory model was intended to explain bottom-up (orthographic) and top-down (knowledge-based) effects on word recognition and works very well in that area. It does not appear to apply to interactions between different knowledge domains.

General vs. Specific Knowledge

The results are less clear as to whether general or specific topic knowledge was necessary to comprehend a text. For both vocabulary and baseball knowledge, specific and general knowledge were so interrelated that it was difficult to tease them out. The factor analysis suggested that the knowledge measures generally reflected a single common factor, as did the vocabulary measures.

The reason we chose two populations in different baseball rooting areas was to ensure that there was a wide variety of knowledge about Seaver. The assumption that he would be more widely known in Long Island was borne out. Long Islanders did know more about their local ball player than did our subjects in Illinois. However, the subjects in Illinois who were highly knowledgeable about baseball, at least major league baseball, also were knowledgeable about Seaver. In fact, knowledge about this specific baseball player was more highly related to other baseball knowledge measures than was a free association task designed to capture breadth of baseball knowledge. It may be that knowledge of more specific information may be a better measure of depth and breadth of domain knowledge than broader or more general probes.

Specific vs. General Vocabulary

In vocabulary, it is difficult to separate general vocabulary knowledge from knowledge of specific words. The moderate correlation between the Nelson-Denny and the target words on the checklist suggests that as one knows more words in general, one is more likely to know any specific set of target words. In this case, the more general measure (the Nelson-Denny) proved to be the better predictor. The reason for this appears simple. The Nelson-Denny probably reflects not only general word knowledge, but some other ability factor. (When the Test of Cognitive Skills, available for the Long Island sample, was entered into the regression equation, the Nelson-Denny was no better predictor than the specific measure of target vocabulary knowledge.)

It is also difficult to separate out the effects of general ability from the specific effects of word knowledge. In this study, the Test of Cognitive Skills, the Nelson-Denny, and the Target Words checklist all share common variance. We have considered this factor to be a word knowledge factor, since it produced effects similar to word difficulty in the other studies, but these effects could be due to differences in ability, as well as differences in vocabulary knowledge.

Strategies for Coping with the Structure of the Passage

Because of the structure of the passage, different subjects adopted different strategies for recalling it. These strategies appeared to be related to students' verbal ability and prior knowledge.

The most involved strategy was to reorganize the information in the text to create a coherent narrative. Subjects who took this approach eliminated the flashbacks and reconstructed the information into a narrative flow. This approach tended to be taken by students with higher vocabulary knowledge. Students with high and low baseball knowledge tended to reconstruct different narratives. Students with high baseball knowledge tended to create a narrative in which Tom Seaver Day was seen as the culmination of a fine baseball career. Students with low baseball knowledge tended to see the retirement of number 41 as the endpoint of a series of numbers worn by Seaver.

Although reconstruction was more difficult, it was also effective. Students who constructed a narrative framework tended to recall more information than students who simply listed facts. Such listers appeared to see the passage as a series of facts. These students tended to have lower than average vocabulary scores. Listing may have resulted from an inability to reconstruct the passage or from an unwillingness to do so.

The third pattern was found in the protocols of only two students, so it may not be a pattern at all. These students were both low in vocabulary but high in specific knowledge of Tom Seaver prior to reading. These gisters gave only general main idea statements in their recall, suggesting that they either did not remember the details or did not choose to put them in their recall. In the quantitative analysis, students with high baseball knowledge were more likely to provide gist statements in their recall than those with low knowledge. These gisters may have been an extreme example of this pattern.

Looking at Text Difficulty

Taken in a broader context, the results of this study, combined with earlier work, suggest a need to reconceptualize comprehension in terms of at least two separable aspects--one involved with the processing of individual propositions and coordinating them into a coherent microstructure and one involved with getting an overall idea or gist of a passage. These are not attempts at defining new comprehension skills, nor should they be taken as hierarchical. They might be useful in relating reader knowledge to different comprehension outcomes. For example, both domain knowledge and vocabulary have been used to measure readability (see Zakaluk & Samuels, 1988). These results suggest that domain knowledge and vocabulary knowledge affect *what* is comprehended as well as *how much*. A text may be difficult for a reader with low vocabulary but high domain knowledge if the comprehension task involves microprocessing, but not if the reader need only get a general idea of what the text is about. The reverse may be true for the same text with a reader with high vocabulary knowledge but low domain knowledge. More exploration of these issues is needed, through sensitive replication using different measures and materials.

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Author Note

We would like to thank Lloyd Humphreys for his careful comments on this paper.

Table 1

Means for Illinois and Long Island Samples on Vocabulary and Knowledge Measures

	Long Island	Illinois
Vocabulary Measures:		
Nelson-Denny	298[a]	302[a]
	(9.9)	(10.3)
Target Words[b]	.65	.64
		(.19)(.17)
Knowledge Measures:		
Baseball Words[b]	.64	.61
	(.16)	(.15)
Free Association - *Tom Seaver*	2.51	1.00
	(2.48)	(1.52)
Free Association - *Baseball*	5.76	4.79
	(2.19)	(1.84)

Note. Standard deviations in parentheses.

[a]A standard score of 298 is equivalent to the 62nd percentile on the Nelson-Denny vocabulary subtest. A standard score of 302 is equivalent to the 72nd percentile. The standard deviation for the national norming sample was set at 15.

[b]Scores from checklist are adjusted using formula in Anderson and Freebody (1983).

Table 2

Correlation Matrix for Vocabulary and Knowledge Measures

	1	2	3	4	5
1. Nelson-Denny Vocabulary					
2. Target Words	.513				
3. Baseball Words	.127	.399			
4. Free Association - *Seaver*	.089	-.028	.281		
5. Free Association - *Baseball*	.187	.228	.024	.168	

Table 3

Principal Components Analysis of Vocabulary and Knowledge Measures, Rotated Matrix

	Factor 1	Factor 2
Nelson-Denny Vocabulary	.802	-.003
Target Words	.882	.074
Baseball Words	.344	.655
Free Association - *Seaver*	-.084	.889
Free Association - *Baseball*	.395	.225
Percent of Total Variance Explained	34.04	25.51

Appendix 1

No. 41 Bids Mets Fans Fond Farewell

Forty-one was not terrific before it appeared on Tom Seaver's back. It was a high number on a team previously distinguished by the frequency with which it lost ball games. That would change within two years of his ascent to the Mets.

Seaver did not request the number, nor had he worn it at any stage of his development. "I'd like to have a romantic story (about how he got it)," he said before it was permanently retired by the franchise he helped transform into a symbol of hope for baseball's downtrodden. "But it was there hanging in my locker when I got to Huggins-Stengel Field."

In the spring of 1967, when Seaver reported to the Mets' camp at St. Petersburg, Fla., he was confident and poised beyond his 22 years. "He has a 35-year-old head on top of a 21-year-old arm," his manager at Jacksonville, Solly Hemus, had said the previous summer. "Usually, we get a 35-year-old arm attached to a 21-year old head."

The rookie was sufficiently seasoned to accept any number as long as it was attached to a big-league uniform.

Seaver's identification with No. 41 never meant that much to him until the numeral was unveiled at Shea Stadium on the occasion of Tom Seaver Day. It was placed alongside the No. 37 and No. 14 worn by former managers Casey Stengel and Gil Hodges, respectively, on what amounts to a wall of fame fronting the left-field bleachers. Seaver was particularly mindful of Hodges, who, more than any other individual, "taught me how to be a professional."

Transpose the digits, of course, and 41 is 14. But Herb Norman, the late equipment manager who doled out numbers to rookies, could not have appreciated the relationship then. Hodges, an original and often injured Met in the expansion season of 1962, was managing the Washington Senators when Seaver arrived.

So it was a happy accident that Seaver was united with 41. "I had no special number in high school and college," he said. He took what was offered to him. In Little League, Seaver recalled, it was No. 13. He wore No. 11 in baseball and basketball in high school. At the University of Southern California, he was handed No. 37 by Rod Dedeaux, a close associate of Stengel. "He would give it to someone he thought was going to be special for him," Seaver said.

"I wore 21 at Jacksonville, and that was a funny story," he added. "I was just a green rookie, and we had a lot of veteran players. They rolled the uniforms in on a rack and everybody made a mad dash for them. There was one left when I got there."

It was Seaver's genius to take an otherwise nondescript number and make it special, just as he made the Mets special for more than half of his two decades in the majors. "I think I was one of the players who gave them credibility," he said, choosing to include such teammates as Bud Harrelson, Jerry Koosman, Jerry Grote, Cleon Jones and Tug McGraw. But Seaver alone was dubbed "The Franchise."

Across town, a man with his credentials -- 311 victories, 3,640 strikeouts, and a 2.86 earned-run average -- might have been honored with a monument. There are no monuments at Shea, not even pillars. For the Mets, Seaver was a foundation

Appendix 1 (continued)

player. With each succeeding old-timers day, he will come to be viewed as a symbol, the Flushing equivalent of a Joe DiMaggio or a Mickey Mantle.

"I don't sense that yet, no," he said of the comparison. "That's something that has to come from the fans, the press." One obvious difference, he noted, was that he didn't play his entire career in New York, thanks to some shoddy treatment by two different management teams. It's true that he pitched his only no-hitter for the Cincinnati Reds, that he won his 300th game in the uniform of the Chicago White Sox, that he amassed 113 victories for teams other than the Mets.

If there was any doubt about where he was leaving his heart, however, it was erased during the emotional ceremony July 24. Instead of a long acceptance speech, he had a better idea of how to thank the crowd. When it came Seaver's turn to salute the fans who had saluted him with a roaring ovation, he jogged to the spot in the ball park where he felt most comfortable.

"I came to a decision a long time ago," he said in preparing the crowd of 46,057 for what was to come, "that if my number was retired, there was one way I wanted to say thank you." And it was not from a lectern set up behind home plate.

No, sir. "If you allow me one moment, I'm going to say thank you in a very special way," Seaver said. "If you know me and how much I love pitching, you'll know what this means to me."

Whereupon he wheeled away from family, friends and startled guests and began a sentimental journey. He wasn't wearing a uniform. He held neither a glove nor a baseball in his hands. Yet, as was the case so often in the past, Seaver was in command as soon as he set foot on the mound.

It was the stage for his first major league appearance, his first victory, his 8 1/3 perfect innings against the Chicago Cubs ("the best game I ever pitched," he said), a World Series triumph in 1969, a 19-strikeout performance (including the final 10 in order) against San Diego, a pennant-clinching victory over the Reds in 1973, three one-hitters and an emotional return on opening-day in 1983. It was also the scene of his final competitive appearance, in a simulated game staged among the Mets a year earlier, at which time he determined that he could not perform up to his standards and abandoned a contemplated comeback.

If any or all of these moments whirled through his mind, he didn't say. But he indicated before the ceremony that he was planning to enjoy the day thoroughly, that it was a time for laughter, not tears.

Then, toeing the rubber, he bowed to everyone, starting at the right field foul line and working his way around to the patrons in the left-field corner. At the completion of the extraordinary and generous gesture, he blew kisses to the multitudes and then, joining his wife and two daughters in the convertible he had received from the Mets and a club sponsor, rode off through the center-field gate into the future.

It was an exclamation point at the end of a wonderful passage, a visually stunning finishing touch to a marvelous career. Tom Seaver was terrific to the end.

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Appendix 2

Words from Anderson-Freebody Checklist

Target Words

poise, nondescript, transpose, contemplate,
unveil, shoddy, downtrodden, transform, simulated,
digit, ascent, amass, ovation, alley, franchise

Baseball Words

fielder, balk, slider, knuckler, inning, bleacher,
shortstop, southpaw, homer, dugout, fungo, bunt,
pitchout, bullpen, jaking, scroogie, twinighter